LIRIOMYZA LANGEI, A NEW SPECIES OF LEAF MINER OF ECONOMIC IMPORTANCE IN CALIFORNIA

([1]Diptera: Agromyzidae)

KENNETH E. FRICK

Irrigation Experiment Station, Prosser, Washington

The agromyzid described below has been confused with *Liriomyza flaveola* (Fallén, 1823) (Lange, 1945; Smith and Lange, 1946; Jefferson and Pence, 1948, 1949), and *L. orbona* (Meigen, 1830) (Melander, 1913; Frost, 1943; Lange and Smith, 1947).

The species is named in honor of W. Harry Lange, Jr., entomologist on the University of California staff, who has studied its biology and methods of control. The common name "pea leaf miner" is suggested since the species has primarily been a pest of garden pea (*pisum sativum*). More recently, this same species has caused damage to aster plantings in southern California (Jefferson and Pence, 1949).

Liriomyza langei Frick, *new species*

Male—Shining black and yellow. Head yellow; ocellar triangle and back of head black, black of back reaching eye margin immediately dorsad of median curve on posterior margin and extending as dusky brown ventrally on genovertical plates between eyes and vti and fronto-orbital setae to lower ifo setae. Antennae yellow, third segment faintly darkened distally; arista black. Proboscis and palpi yellow. Thorax with mesonotum shining black, extending laterally to humeri, prs, sa, and outer pa setae; anepisternum (fig. 1) mostly black, narrowly yellow posteriorly, rather broadly so dorsally, ventral margin irregular; katepisternum (fig. 1) broadly black, narrowly yellow dorsally; anepimeron black, yellow margin anteriorly rather broad, narrow ventrally. Legs black, tips of femora yellowish, fore- and mid-femora yellowish brown to yellowish on inner sides nearly to trocanters; tarsi black. Halteres yellowish. Wings hyaline, calypters gray, margins blackened; setulae of fringe black. Abdomen black dorsally; first segment anteriorly very narrowly yellow; all segments but first posteriorly very narrowly yellow, i.e., posterior of last row of setulae; pleurae yellow; sternites broadly yellow posteriorly, brownish anteriorly. Hypandrium black; cerci yellow.

Head—Eyes large. Genae rather elongate ventrally, more so posteriorly, one-third eye height midway between posterior margin and vibrissa; only slightly sunken centrally; four setae on subcranial margin; vibrissa about three times as long as these setae; parafacial

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region raised above eye margin, genovertical plates only slightly so. Genovertical plates moderately broad, each approximately one-fourth width between eyes; two ifo (three on one side); two sfo, all subequal in length; os small, sparse, about five in number, dorsalmost slightly dorsad of lower sfo. Frontal vitta two-thirds as broad as long, very slightly sunken below genovertical plates; ocellar triangle of normal size, about four small setulae, ocellar setae long, nearly equaling frontal vitta. Lunule small, semicircular in outline; mesofacial plate about two-thirds as long as broad, a very low rounded median carina becoming inconspicuous between approximate antennal bases; postclypeus narrow, not over one-fourth height of mesofacial plate. Antennae with third segment rounded, broader than long, in width one-third eye height, very finely pubescent; arista short, two and a half times as long as height of third segment, slightly swollen on basal fourth. Proboscis rather large; palpi short, cylindrical.

Thorax—Mesonotum slightly longer than broad; one h and three and five setulae on humeri; one prs, a setula less than one-third length of prs anterior to it; one sa; 0 ia, five to seven setulae in ia row; two pa, inner strong, two-thirds length of outer; 3 + 1 dc, strong, a setula about one-third length of fourth immediately anterior to it; distances between them, beginning with first, 2.25 : 1.75 : 2; acr sparse, relatively long, ten in about four irregular rows reaching posteriorly to second dc. Pleurae with pp very strong; two npl, strong, subequal; one aes, two setulae near dorsal margin dorsally directed, two on posterior margin posteriorly directed, one dorsad of and the other ventrad of aes (fig. 1); one kes, one setula anterior to it, dorsally directed.

Legs—All tibiae with a short apical spur, two on mid-tibiae, stronger; no setae centrally on mid-tibiae.

Wings—About two and one-fourth times as long as broad, veins strong; costa reaching M_{1+2}, distad of wing tip; costal segments in proportions of 7 : 1.75 : 1.5; crossvein r-m basad of termination of R_1 in costa; crossvein m-m present, at an oblique angle, 1.2 times its length from r-m; ultimate section of R_{4+5} about nine times as long as penultimate; ultimate section of M_{1+2} nearly 7.5 times as long as penultimate; ultimate section of M_{3+4} about two times as long as penultimate, ending in margin two-thirds of distance from wing base to apex; Cu + Pl extending about three-fourths of distance to wing margin.

Abdomen—Elongate ovoid; rather sparsely covered with moderately long slender setulae; hypandrium with very few setae.

Size—1.75 mm. in body length; wing: 1.75 mm. in length.

Female—Similar to male in coloration and general appearance; os setae extending slightly dorsad of lower sfo, six and eight in number; second antennal segments slightly darkened; three setulae on each humerus; acr setae about 23 in number, four irregular rows reaching posteriorly to second dc; anepisternum with three posteriorly directed setulae, two dorsad of aes; sixth abdominal

segment with posterior yellow margin rather broad, one-fourth width of segment; seventh segment large, conical, one-fourth length of abdomen; two irregular rows of relatively long setulae on posterior half; shining black.

Size— 2 mm. in body length; wing: 2 mm. in length.

Holotype ♂: SUNNYVALE, SANTA CLARA COUNTY, CALIFORNIA, October 15, 1948, K. E. Frick, reared from a leaf mine on garden pea; deposited in the California Academy of Sciences. *Paratypes:* 17 ♂♂, 29 ♀♀, topotypical; 2 ♂♂, 6♀♀, Sunnyvale, Santa Clara County, California, September 28, 1948, K. E. Frick, reared from leaf mines on sugar beet; 1 ♂, 3 ♀♀, Salinas, Monterey County, California, October 30, 1948, K. E. Frick, reared from leaf mines in packages of spinach purchased in Berkeley, California, grocery stores; 3♂♂, Sunnyvale, Santa Clara County, California, September 27, 1948, K. E. Frick, reared from leaf mines on celery; 3 ♂♂, 1 ♀, Soledad, Monterey County, California, November, 1946, A. J. Walz, reared from leaf mines on spinach; 5 ♂♂, 6 ♀♀, San Jose, Santa Clara County, California, October 23, 1928, University of California collection, reared from mines on pea.

Other material examined.—A single specimen, Pullman, Whitman County, Washington, "Webster #5938, Aug. - 5 - 18," reared from leaf mine on pea, leaf and puparium on pin, and other specimens from Washington and Idaho, all in Melander's collection; 82 ♂♂, 87♀♀, topotypical (in alcohol); 25 ♂♂, 15 ♀♀, Sunnyvale, Santa Clara County, California, September 9, 1948, K. E.

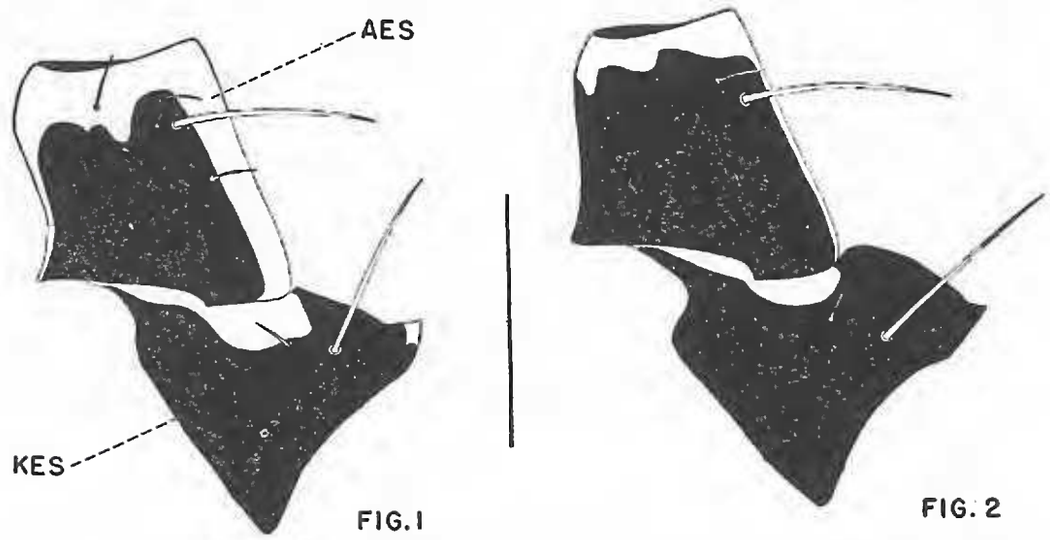

Fig. 1. Anepisternum (AES) and katepisternum (KES) of the holotype ♂ of *Liriomyza langei* n. sp., showing the distribution of yellow and black areas. The solid line equals 0.5 mm.

Fig. 2. Anepisternum and katepisternum of a homotype ♀ of *Liriomyza orbona* (Meigen, 1830), showing distribution of yellow and black areas.

Frick, swept from sugar beet field; 1 ♀, Berkeley, Alameda County, California, November 1, 1948, K. E. Frick, reared from leaf mine on sugar beet; 4 ♀♀, Sunnyvale, Santa Clara County, California, September 9, 1948, K. E. Frick, swept from celery field; 1 ♂, Berkeley, Alameda County, California, October 20, 1948, K. E. Frick, reared from leaf mine on celery grown in a greenhouse; 4♂♂, 1♀, Berkeley, Alameda County, California, November 13, 1948, K. E. Frick,, reared from leaf mine on aster or as adults on asters leaves in a greenhouse; 6 ♂♂, 39♀♀, Torrence, Los Angeles County, California, 1948, R. N. Jefferson, reared from leaf mines on aster (in alcohol).

Liriomyza orbona Meigen differs from *L. langei* as follows:

Adult homotype ♀—Dusky color of genovertical plates extending only to lower sfo; third antennal segment yellow on basal two-thirds, abruptly becoming dark brown distally; palpi brownish. Anepisternum black, a very narrow yellow strip on dorsal and posterior margins (Fig 2); katepisternum black, a very small yellowish area dorsally (Fig. 2). First and second abdominal tergites yellow laterally; fourth and fifth entirely black; sixth yellow posteriorly, about one-fifth of tergal width. Head (Hendel, 1931, Fig. 248)—Genae half eye height midway between vibrissa and posterior margin, genovertical plates and parafacial region greatly exceeding eye margin; postclypeus nearly half height of mesofacial plate. Thorax—Setula anterior to prs not differentiated from acr; O ia, about seven setulae in ia row; distances between dc setae, 1.75 : 1.5 : 2; no differentiated setulae anterior to fourth dc; about 30 acr, extending posteriorly nearly to first dc. Wings (Hendel, 1931, Fig. 247)—Costal segments in proportions of 8:2:1.75; crossvein r-m and termination of R_1 about equidistant from base of wing; crossvein m-m less than its own length from r-m; ultimate section of R_{4+5} about 6.5 times as long as penultimate; ultimate section of M_{1+2} about 16 times as long as penultimate; ultimate of M_{3+4} slightly less than 2.5 times the penultimate.

Male terminalia (de Meijere, 1925:289, Fig. 58c, surstylus).—Surstyli bearing setae; strong tooth absent.

Puparium (de Meijere, 1925:273)—Posterior spiracles with about 12 subequal bulbs arranged in an arc; anal lobes small, short, truncate.

Liriomyza orbona is not common in Europe, and the species has never been reared from larvae. De Meijere (1925) reared *L. orbona* adults from puparia found in the debris and refuse left by an overflowing of the Rhein River near Lotith in 1924. The species was not mentioned in subsequent papers. Hendel (1931) mentioned that the ecology was unknown, but since the adults were repeatedly found in meadows, he felt that the larvae are probably grass miners.

Hering recently stated in correspondence that the larvae are probably grass miners.

Hendel (1931) found *Liriomyza orbona* so closely related to *L. flaveola* that he referred to the thoracic setal pattern of the latter species in describing *L. orbona*, noting but a few minor differences. De Meijere (1925) states that the puparium of *L. orbona* is similar to those of *L. flaveola* and of the "*L. pusilla* complex." Hering found several differences between adults of *L. orbona* and *L. langei*, based on material sent to him, adding that *L. langei* does not occur in Europe.

Liriomyza langei may be distinguished from other species of *Liriomyza* by the large size, characteristic wing venation, and distinctive color pattern, particularly of the thoracic pleural region. The new species is closely related to the European *L. orbona* and therefore rather close to *L. flaveola*. On the basis of the form of the surstyli, *L. langei* appears to be closer to the species in the "*L. pusilla* complex" than to *L. orbona*. Hering found that leaves sent to him containing mines made by the larvae of *L. langei* were very similar to those made by the larvae of the European *L. strigata*.

VARIATIONS WITHIN THE SPECIES

The specimens of this species are quite constant in most characters, particularly in the coloration. The setae vary within relatively narrow limits, the os setae varying from three to eight, sometimes not extending dorsad of the lower sfo; only rarely do three ifo occur on one side (as in the holotype ♂); humeral setulae vary from two to five, with usually three or four present; the acr setae sometimes extend posteriorly to the second dc but are always sparse; an extra posteriorly directed setula sometimes occurs on the anepisternum, and one of the dorsally directed ones is sometimes absent. The most striking variation is the loss of the m - m crossvein (Table I). The crossvein may be vestigial, often being reduced to one or two short vestiges, or absent. The figures indicate that the females tend to have slightly more variation than the males, and that the absence of the crossveins is relatively rare, particularly where one is absent in one wing and the other complete in the other wing.

LARVA

(Described from larvae obtained from mines in *Pisum sativum* leaves and preserved in alcohol.) Large, 3.25 mm. in length, five-eights to three-fourths mm. in diameter. White, yellowish on anterior one-third, shining.

Head—Antennae minute, light brown; palpi relatively large, blackish; longitudinal sclerite inconspicuous, narrow, light brown, lateroventral arms not discernible. Mandibles each with two teeth, alternated; labial sclerite three-fourths the length of mandibles, moderately broad, visibly partially separated from paraclypeal phragma; dorsal arm three times the length of labial sclerite, curving anteriorly, nearly straight posteriorly, not narrowing but becoming paler posteriorly; ventral arm two-thirds the length of dorsal, very slender, nearly straight.

Body—Anterior spiracles small, scarcely expanded distally; six bulbs arranged in a single inwardly curving row. Cuticular processes minute, of one size; bands relatively narrow. Posterior spiracles of moderate size; somewhat expanded distally, more so ventrally; seven or eight bulbs, rather widely spaced, arranged in a semicircle, open towards midline. Posterior end truncate; a pair of minute lateral lobes two-thirds of distance from dorsal surface; anal lobes very small, rounded. Calcospherites numerous; large, many slightly over one-sixth larval diameter.

Puparium—Large, 2 mm. in length, nearly 2 mm. in width and height. Reddish brown in color. Subcylindrical, laterally sides subparallel, tapering rather sharply at the ends; ventral surface flattened, dorsal arched; segmentation distinct. Anterior spiracles rather close together, same form as in larva; posterior spiracles subdorsal, about twice as far apart as anterior, moderately long, of same form as in larva. Anal slit dark brown, lateral lobes absent.

Description of the Leaf Mines

The mines are characterized by being relatively wide, even from the start, and often widen to as much as twice the larval width for most of the length. The mines are serpentine and are often so twisted as to cross many times, sometimes having a blotch-like appearance. The frass is deposited almost entirely in small strings forming a nearly continuous slender black line down the center of the mine. The mines are primarily on the dorsal surface of the leaves, but often extend to the ventral, and are usually on the basal half of the leaves, often running down the petioles from which place the larva emerges.

Certain modifications in the mines are found in each species of host plant, and notes are added here based upon mined leaves in the writer's collection. On aster, the mines are usually basal on the leaves, extending down the petiole, often to its base. The lateral ribs appear not to impede larval movement. On pea, the mines are on both surfaces, single mines often alternating. The midribs and lateral ribs seem to act as barriers, the mines usually being confined to a relatively small area and appearing blotch like. There are often two or three mines per leaf, and they are often found on the stems

TABLE 1

Percentages of loss of crossvein m-m in the wings of 455 adults of *Liriomyza langei* n. sp.

Condition of m-m crossveins per specimen	MALE Host	Number	%	FEMALE Host	Number	%	TOTAL Number	%
2 complete	Pea (Sunnyvale)	99	80.4	Pea (Sunnyvale)	117	66.1		
	(San Jose)	5	100.0	(San Jose)	6	100.0		
	Sugar Beet	36	97.3	Sugar Beet	28	80.0		
	Celery	4	80.0	Celery	4	66.6		
	Spinach (Salinas)	2	100.0	Spinach (Salinas)	1	33.3		
	(Soledad)	2	66.6	Aster (Berkeley)	3	100.0		
	Aster (Berkeley)	3	75.0	(Torrence)	35	89.7	350	76.9
	(Torrence)	5	83.3					
1 complete	Pea (Sunnyvale)	9	7.3	Pea (Sunnyvale)	20	11.2		
1 vestigial	Spinach (Soledad)	1	33.3	Sugar Beet	3	8.6		
				Spinach (Soledad)	1	100.0	34	7.5
1 complete	Pea (Sunnyvale)	1	.8	Pea (Sunnyvale)	1	.6		
1 absent	Sugar Beet	1	2.7				3	.66
2 vestigial	Pea (Sunnyvale)	9	7.3	Pea (Sunnyvale)	23	12.9		
	Aster (Berkeley)	1	25.0	Sugar Beet	2	5.7		
	(Torrence)	1	16.6	Celery	2	33.3		
				Spinach (Salinas)	1	33.3		
				Aster (Torrence)	3	7.7	42	9.2
1 vestigial	Pea (Sunnyvale)	3	2.4	Pea (Sunnyvale)	11	6.2		
1 absent	Celery	1	20.0	Sugar Beet	2	5.7		
							17	3.7
2 absent	Pea (Sunnyvale)	2	1.6	Pea (Sunnyvale)	5	2.8		
				Spinach (Salinas)	1	33.3		
				Aster (Torrence)	1	2.6	9	1.9

and pods. Mines on celery are similar to those found on aster in that the mines are usually on the basal portions and often extend down the petiole. However, the leaf ribs appear to inhibit movement and the mines appear to be blotches. The mines on the large leaves of sugar beet and spinach are similar, being found rather often on the outer portions of the leaves, and are not so twisted, but still serpentine.

Acknowledgments

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